TWENTY-FIFTH ANNUAL REPORT 1951

CENTRAL STATES
FOREST EXPERIMENT STATION
Columbus 13, Ohio
PHILIP A. BRIEGLEB, DIRECTOR

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INTRODUCTION

Individuals and institutions alike found 1951 a year of adjustment and change. Certainly the Central States Forest Experiment Station was no exception. Changes in world and local conditions created new resource management problems and brought demands for new solutions.

Most of these problems were related to the defense effort. As shortages in materials and personnel develop, an equitable system of priorities and allocations of supplies is needed. Thus, at the request of the National Production Authority, the Forest Service, with the cooperation of industry, undertook a Nation-wide survey of equipment and manpower needs of the logging and primary wood-processing industries. This Station was responsible for the work in the Central States area.

Station staff members took part in a Forest Service study of military timber requirements for the Department of Defense. We also worked with the Army in developing ways of locating and eliminating bullets and shrapnel from standing trees and logs so they could be manufactured into useful products without hazard to workmen or costly damage to processing machinery. On another project undertaken by the Forest Service for the Army, two staff members were assigned part time to the photo interpretation of land-use conditions on the Ryukyu Islands. Still other members of the staff, at the request of the National Production Authority, helped investigate forest industry applications for accelerated amortization of proposed plant expansions.

In response to a growing concern over the damage caused by oak wilt disease, the Station undertook new studies related to wilt control in cooperation with the Bureau of Plant Industry.

These new tasks involved some sacrifice in the progress of established research projects, but fortunately it was possible to continue major long-time studies on schedule. Some other studies were slowed; the start of some urgent but neglected projects had to be delayed.

In spite of these special projects, we made significant progress on our regular work. Field work of the Forest Survey in

Kentucky was completed and a good start was made on the forest inventory in Ohio. A marketing study on southern Illinois was completed and the results were published. The publication analyzes problems of marketing products from farm woodlands and recommends steps to increase the contribution of these forests to farm income through better marketing.

Demands for information on better wood-utilization practices continued high. In response, the Station took part in a short course in small-mill operating technique, two log grading schools for forestry field leaders, and a gluing clinic for fabrication technicians during the year. Station Utilization specialists provided on-the-ground consulting services to more than 140 wood harvesting and processing operations.

An analysis of the principal forest problems in the Northern Ozark problem area was completed, reviewed by the problem area research advisory committee, and the research program was oriented to concentrate our efforts on recommended first-priority projects. On the Mark Twain National Forest, a new experimental forest, representative of the extensive post oak-blackjack type, was selected for future development. Progress in developing better ways of establishing a forest cover by planting on strip-mine banks, abandoned fields, and understocked forest land was reported in a series of publications during the year. A method of estimating the growth capacity of white oak sites from soil and topographic characteristics was devised in southeastern Ohio. Comprehensive commercial-scale tests of different cutting methods and stand-rehabilitation techniques progressed according to plan on the Kaskaskia Experimental Forest in southern Illinois. These studies are showing how trees of poor quality and growth-potential can be removed, at a profit where good markets are available, to release the trees of better quality and vigor for future growth.

The first year of activity on the fire research project at the Northern Ozark Branch was completed with a survey of the fire-control job and preparation of a fire problem analysis that will provide a basis for establishing study priorities. This project is sponsored jointly by Region 9 of the Forest Service, the Missouri Division of Forestry, and the Station.

Also in the Northern Ozarks, various ways of controlling sprouts chemically are being tested as a means of improving range lands. The results of range reseeding studies indicate that the net income that can be realized from grazing cattle on improved pasture is likely to be significantly higher than can be obtained from native forage.

Extremely destructive floods in 1951 dramatized in a bitter and costly way the need for far better watershed management in the

Central States. When the worst overflows were occurring, about midyear, the Station's Flood Control Surveys Section was being disbanded in an economy effort. In response to the new flood catastrophes, Congress made funds available for pushing the flood surveys program, and this work was reactivated at the Station with challenging incentive. The report for the Green River Watershed of Kentucky and Tennessee, first postwar flood control survey report to be printed as a Congressional document, was published in December. This document recommends a vigorous watershed improvement program estimated to have a favorable benefit-cost ratio. Studies of root concentration, soil-moisture trends, and water storage in forest soils made at the Buckeye Branch during the year provided more information on influence of forest cover on the water cycle.

Former Director of the Central States Station, Harold L. Mitchell, was transferred to the Directorship of the Southern Forest Experiment Station about midyear, and Philip A. Briegleb was transferred to the Central States Directorship from the Pacific Northwest Station.

Some details of the changes and progress made in the various divisions, the new problems encountered, the usable results obtained, and our plans for the future are given on the following pages.

FOREST ECONOMICS

The Station's activity in Forest Economics research declined somewhat during 1951. This was due partly to a reduction in funds available, partly to a decline in purchasing power of the dollar, and partly to demands for the skills of staff members in other work related to the defense effort.

For the fiscal year starting July 1, 1951, Forest Survey funds were cut about 15 percent; Research and Marketing Act funds were halved. To adjust to this change, Hutchison was transferred from marketing research to the Survey as a report writer. In addition, the Survey inventory field force was cut from four men to two, and the office force was reduced through resignations, leaves, and transfers by three technical men and one clerk. In addition, one technical man was assigned for approximately 6 months to the Station's Flood Control project.

Much time was spent by Division personnel on special projects. King spent about 6 months heading up the Station's work on a Nation-wide study of the equipment and manpower needs of the forest products industries. A number of other Station members in this and in the other divisions also participated in this work, which was undertaken at the request of the National Production Authority.

Beginning about July 1, Moessner and Jensen were assigned part time to the photo interpretation of land-use conditions on the Ryukyu Islands (other than Okinawa). This project is being undertaken by the Forest Service for the Army. The object is to make a land-use classification survey of the islands and to estimate the timber volume. The aerial-photo work is being done at this Station.

Winters was detailed to Washington for 2 months to help revise Service policy on conservation payments for forestry practices under the Agricultural Conservation Program of the U. S. Department of Agriculture.

During the year we gave special attention to developing photo techniques. The main purpose of this effort was to find ways in which the number of Forest Survey field plots could be reduced by relying more upon the interpretation of aerial photos. In a 10-county area in western Ohio a study was undertaken to see if the correlation of photo and field volumes could be improved by measuring the volume on two--rather than one--1/5-acre plots at each field location.

FOREST SURVEY

Since July 1, 1946, the Forest Survey at this Station has completed field work in Missouri, Illinois, Kentucky, and Indiana, and this year made a good start in Ohio. To finish the initial survey job assigned to us, Ohio and Iowa and the forested parts of such "fringe" states as Kansas and Nebraska must be completed. As nearly as can be estimated, the total job of field work, computation, analysis, and report writing for this Station's territory is about three-fourths completed.

A more detailed, state-by-state report on Survey progress follows:

Missouri.--The initial Forest Survey work in Missouri was completed with the publication of the state analytical report in 1950.

Illinois.--Owing to the 6-month assignment of King to the equipment and manpower survey, progress on the analytical Survey report for Illinois was retarded. At year's end this manuscript had been reviewed, revised, and edited. When released, the report will show that forests occupy 11 percent of the land area of the state and support more than 10 billion board feet of saw timber. For the state as a whole the timber volume is increasing; during 1947 the saw-timber cutting drain amounted to 41 percent of the net growth. During the same year the drain on the higher-quality (grade 1 and 2) logs amounted to three-fourths of the higher-quality saw-timber net growth. Offsetting these rather favorable points, the quality of the saw-timber stand is low (more than three-fourths in log grade 3), the volume per acre is also relatively low (2600 board feet per acre), and much of the forest growing space is occupied by cull trees (nearly one-fifth). Apparently the timber resource of Illinois is improving, but it needs much further improvement.

Hutchison devised a way to prepare generalized forest cover maps for states or parts of states by assembling a mosaic of photo-index sheets. A map of this kind was prepared for southern Illinois, and the procedure was described in a short article submitted for publication in the Journal of Forestry.

Kentucky.--Inventory field work was resumed in Kentucky January 6, 1951. Only the eight southeastern counties had been unfinished because of the lack of aerial photographs. The inventory field work in these counties was completed in July. By the end of the year the forest area, timber volume, and growth data had been compiled and the analytical report was being prepared. A series of Kentucky maps showing the distribution and approximate

frequency of several important tree species were prepared. They will be published as a Survey Release.

In Kentucky the woods waste and sawmill studies indicate that about 10 percent of the saw-timber volume cut is left in the woods as woods waste. Approximately 46 percent of the volume of logs taken to sawmills is in log grades 1 and 2 combined and 54 percent is in grade 3.

Indiana.--The forest area, timber volume, and drain computations were completed during the year. The growth computations are not yet completed. A start has been made on the analytical report.

Sawmill studies in Indiana indicate that approximately half of the volume of logs taken to sawmills were in log grades 1 and 2 combined and the other half in log grade 3.

Analysis of the stump drain data obtained in Indiana indicates that the procedures used there for estimating timber drain from stumps on field plots did not provide an adequate basis for determining timber drain. This work did, however, supply a satisfactory basis for allocating drain to species and species groups, stand-size class, and tree-diameter class.

Ohio.--Inventory field work was begun in Ohio August 1, 1951, and by the end of the year had covered approximately 25 percent of the estimated forest area in the state. Plans for a drain survey were prepared and submitted to Washington for approval.

Stump drain studies are being continued in Ohio and have been modified on the basis of experience gained in Indiana.

Plans for 1952

Illinois.--The analytical report for the State of Illinois should be published before the end of the year.

Kentucky.--The state statistical report should be issued during the year, and the analytical report should be completed in first-draft form. Tree-species distribution maps will be published as a Survey Release.

Indiana.--The state statistical report should be issued and the analytical report should be completed in first draft.

Ohio.--In all probability the field inventory will not be completed during 1952. Drain field work and computations should be completed. Computations of forest area and timber volume statistics for one or more units in Ohio may be completed during the year.

MARKETING FARM WOODLAND PRODUCTS

Farm woodland marketing research is carried on at the Station under authority of the Research and Marketing Act of 1946. The objectives of this work are to help develop new and expanded outlets for farm forest products and to determine and report on the best methods of processing, handling, transporting, and marketing such products.

About 65 percent of the forested land in the Central States is owned by farmers, and in some counties farm woodlands account for as much as 50 percent of the farm area. However, even in these counties farmers obtain less than 5 percent of their income from the sale of forest products. If farmers are to realize the potential returns from their farm woodlands, they need more efficient marketing methods and better market outlets.

Our marketing research has been centered in Missouri and southern Illinois, two areas where farm woodland problems are especially acute. In these areas lists of timber buyers have been prepared and studies have been made to find improved marketing methods and the need and opportunity for establishing new markets. Reports on these studies are being published.

Missouri.--A study to determine the pine resource and the opportunity for expanding markets for pine timber was practically completed. This study was made in cooperation with the Missouri Division of Resources and Development. A report, "Fence Posts, A Potential Market for Missouri Pine Timber," was published in December. The results show that although most farmers in northwest Missouri are still using hedge posts, more and more of them are beginning to use treated pine posts because they are strong and easy to handle, have a long service life, and make neat fences. In addition, hedge posts are becoming harder to get because hedge rows--the source of hedge posts--are being removed. The average farmer planned to buy about 69 posts in 1951; of these, he expected that about one-fourth would be treated pine. This is a substantial increase over the number he bought in 1949 and indicates a growing demand for treated pine posts in the cornbelt region that may provide a new market for small pine timber from the Missouri Ozarks.

Other phases of the study indicate that most of the pine volume in the Missouri Ozarks is in well-stocked stands of young trees less than 12 inches d.b.h. Thinning operations are desirable in most of these stands to improve growth, to best utilize the pine timber, and to obtain an early financial return. The cubic foot volume of pine is increasing at a rate of about 8 percent per year.

At present, sawmills are the only widespread and dependable market for pine in this area. The present pine saw-timber cut is

less than growth and, except on managed land, is often a clear-cutting operation providing only marginal returns because of the small size of the logs.

The study indicates that there is both a need and an opportunity for a more diversified pine industry in the area.

A demand for pine posts or pulpwood in the area would provide a market for thinnings from small pine timber not now merchantable as sawlogs. These markets would provide an early financial return to the owner, additional woods work, and at the same time, an opportunity for better forest management and utilization. Another possibility is a pole market, even though very little of the pine timber is now suitable for high-quality poles. Small poles could be cut and this market should encourage woodland owners to save some of their best trees for high-quality poles. A report giving detailed information on the pine resources and market opportunities will be published in 1952.

Illinois.--The technical report entitled "Marketing the Farm Forest Products of Southern Illinois" was completed and published in cooperation with Southern Illinois University. This paper describes the forest resources and markets in southern Illinois and suggests ways that the forests can contribute more to the income of the region through better marketing. These suggestions include expanded markets for low-quality timber, increased local processing and remanufacturing of timber, development of new marketing facilities, and more information regarding timber markets.

Plans for a survey of primary and secondary wood markets in southern Illinois and adjacent areas were prepared in cooperation with Southern Illinois University. The University is making the survey. Because Research and Marketing Act funds were reduced, this work in Illinois was suspended at midyear.

Plans for 1952

First priority will be given to completing and publishing a report on pine resources and market opportunities in the Missouri Ozarks. We are now studying the needs for woodland products marketing research in other parts of the Station's territory, and presently will determine the kind of work and the area to be covered in the next marketing studies.

FOREST UTILIZATION SERVICE

The Forest Utilization Service was established at this Station in March 1946 as a field arm of the Forest Products Laboratory. The basic objectives of this activity are (1) to improve wood utilization by encouraging the application of the most efficient equipment and processes in harvesting, treating, fabricating, and manufacturing forest products and (2) to stimulate the development of better methods by bringing to the attention of Laboratory technicians the most pressing utilization problems of the region.

Since there are over 20,000 individual wood-using establishments in the region, it is obviously impossible to work directly with more than a small segment of the industry. As a result, this work is done most effectively through organizations, such as trade associations, technical and research societies, state and local industrial organizations, state agricultural extension services, and farm foresters. Part of the job is also to keep in touch with private, state, and regional forest products research agencies. Through 1951 the Forest Utilization Service staff consisted of two specialists, one concerned principally with problems of the primary (wood-producing) industries and the other with problems of the secondary (wood-using) industries.

The Central States is primarily a wood-consuming region. Region-wide, not more than 15 percent of the wood used by our secondary industries is produced locally. In such a region the problems of the secondary industries would appear to be very important, and indeed they are. Nevertheless, some of the most pressing utilization problems and those whose solutions promise the greatest returns in the conservation of timber resources are those of the primary processors--the small rural sawmills (there are more than 11,000 in the region) and the producers of veneer logs and bolts, cooperage stock, and other wood products harvested and marketed primarily in the round. This conclusion rests chiefly on the fact that our primary forest industries are mostly small, rural, highly individualistic, and are not as completely mechanized as they should be. In contrast, most secondary industries are urban or suburban and are usually closely knit in effective trade associations. They are, as a rule, better financed and more highly mechanized. At least 90 percent of the forest products harvested in the Central States are from farm woods and 80 percent of the lumber produced is manufactured at small rural mills using farm labor. Methods and equipment at these operations are commonly inefficient and obsolete.

PRIMARY INDUSTRIES

The program in the field of primary industries this year was largely focused on reaching more of the small, rural operations. Established farm organizations, especially the agricultural extension services, the soil conservation districts, and the farm forestry programs, have increasingly taken part in the program. Examples of this include: annual sawmill and logging equipment demonstrations which have been held in Illinois, Indiana, and Ohio in recent years; a short course in small sawmill technique held in Illinois in March to train extension foresters, and two log grading schools held in Ohio and Kentucky last summer to train leaders. The effectiveness of this approach is indicated by the increasing demand for demonstrations, not only from the farm and extension foresters but from individuals in industry itself.

On-the-ground consulting and advisory services were extended to about 25 sawmill and other operators on specific utilization problems ranging from the use of proper equipment to the preparation of plans for construction projects at small to moderate-size mills. For example, we cooperated with the Muskingum Conservancy District in working out answers to the plant layout, machinery, and equipment problems encountered in managing the District's 15,000 acres of forest land and utilizing the products. As a result, major changes in their transportation and mill layout should lower lumber production costs by at least 40 percent. Similar work with an organ manufacturer in northern Ohio enabled him to effect major savings in handling kiln-dried lumber. He was able to eliminate the need for a large inventory and thus free badly needed factory space.

For several years, in cooperation with the Forest Products Laboratory, we have been consulting with manufacturers of farm and logging equipment on problems of harvesting small volumes of timber from farm woods. Some progress has been made, particularly in developing inexpensive attachments which will improve the efficiency of farm equipment for this purpose.

Although funds and time available prevented extensive participation, we reviewed work plans and in some cases provided on-the-ground consultation and advice to the Station's branches and experimental forests on utilization problems associated with their normal research activities.

About 200 inquiries on a wide variety of utilization problems were handled by correspondence or were referred to the Forest Products Laboratory during the year.

SECONDARY INDUSTRIES

In the field of remanufacture, fabrication, and chemical conversion of forest products, the secondary industry specialist devoted about 40 percent of his time to maintaining field contacts with individual establishments. New developments and current manufacturing problems received major attention. The increasing use of the facilities of the Forest Products Laboratory shows that these industries are interested in applying the results of wood products research. Furniture manufacturers especially are making better use of available lumber--often of different species or lower grades than were previously used for the same purposes. The Mersman Brothers Corporation of Celina, Ohio, and the Keller Manufacturing Company of Corydon, Indiana, are noteworthy examples of companies practicing closer utilization.

We made calls at 117 different plants where processing and wood utilization problems were discussed with the management. Technical information was furnished directly or by the Madison Laboratory.

A gluing clinic was conducted at the Laboratory, organized jointly by the Station and the National Woodwork Manufacturers Association. Twenty-six representatives of millwork and laminated-timber producers attended.

Experiments started in 1950 in the feeding of cattle with grass-legume silage preserved with wood-sugar molasses were continued at three stations--one operated by the University of Illinois and two by the University of Missouri. The molasses was made by the hydrolysis of hardwood chips at the TVA pilot plant. These tests generally confirm results of similar experiments in other regions. The grass silage preserved with wood-sugar molasses seems to be equal in palatability and food value to silage preserved with blackstrap (cane-sugar) molasses. Both Universities want to continue the tests through 1952 before publishing the results.

OTHER ACTIVITIES

Both members of the staff contributed more than one-third of their time during the year to Station- or Service-wide projects directly or indirectly associated with National defense. The survey of military lumber requirements drew extensively on the time of both men during late winter and early spring. It was made for the U. S. Corps of Engineers whose St. Louis office is responsible for all lumber and wood products procurement for all of the armed services. In the Central States we visited 12 installations to get information on problems of lumber procurement, storage, and use. This information has been analyzed by the Forest Products

Laboratory, and a handbook for use at military installations is being prepared.

The Nation-wide survey of manpower and equipment, also participated in by other divisions of the Station, occupied several man-months during late spring and early summer. A week or 10 days were devoted to investigating amortization cases referred to the Forest Service by the National Production Authority.

Brundage was on emergency detail to Fort Eustis, Virginia, for about 2 months on a problem of harvesting contaminated saw timber. The timber was on a small arms and artillery range and had been rather heavily contaminated with bullets and shrapnel during World War I. Using the Army SCR-625 mine detector, methods were worked out for detecting areas of excessive contamination and for locating and eliminating metal from logs going to the sawmill.

Throughout the year we worked closely with other divisions and branches of the Station on projects described elsewhere in this report. For example, the Ames Branch and Iowa State College are particularly interested in the use of sawdust, shavings, wood chips, and lignin as livestock bedding and agricultural mulch. The Ames Branch bought a portable chipper for working up tree tops, limbs, and thinnings for such purposes and is making tests and demonstrations in cooperation with the Iowa Extension Forester.

During the year several companies asked for all available information on timber stands and sources and volumes of mill wastes. Several conferences with Laboratory pulp and paper specialists have been arranged for individuals and companies seeking information on the suitability of certain hardwood species for pulping. One company in Ohio that is now operating a semichemical straw mill is definitely planning to switch to soft hardwood wastes as a source of raw material.

With the exception of roofing felts, semichemical pulps, fiber boards, and similar items, we do not visualize any immediate major industrial development in the pulp field in this area. The limiting factor is not wood, however, but water. At present the high-grade pulp and paper industry demands tremendous quantities of water low in organic and inorganic solids. This demand for high-quality water in abundance can be met in only a few places in the entire Central States territory.

M. R. "Doc" Brundage, our secondary industries specialist, retired from the Forest Service on December 31. Doc had been with the Forest Utilization Service since it started in 1946.

PLANS FOR 1952

With the retirement of Brundage we must not only adjust our current work projects but re-examine our long-range objectives and program. Our plans for 1952 are grouped into those of high priority --those that should be completed this calendar year--and relatively low priority--those that are very desirable but may be postponed without seriously disrupting earlier commitments or cooperative obligations.

High priority projects:

1. Review of the long-term Forest Utilization Service program.
2. Southern Ohio equipment demonstration.
3. Participation in branch station and experimental forest projects.
4. Southern Illinois log grading school.
5. Complete cooperative work on molasses feeding tests.
6. Organization of an Ohio Valley section of the Forest Products Research Society.

Lower priority projects:

1. Small sawmill training schools.
2. Additional log grading instruction.
3. Survey of farm woodland harvesting problems.
4. Small capacity dry kilns.

Of the six high-priority projects, the complete review and re-examination of the long-range program is undoubtedly the most important. This will involve conferences with representative industries, public and private forestry organizations, forestry schools and departments, trade associations, regional officers and supervisors of the Forest Service, and, of course, our own work center and division staffs. As part of the project, an up-to-date problem analysis will be prepared.

The Ohio Agricultural Extension Service is sponsoring this year's logging show to be held in southeastern Ohio, October 15

and 16. We will again have charge of the active demonstrations of all logging and sawmilling equipment.

More time will be spent on supervising utilization studies at branch stations and experimental forests. The staff of the Forest Products Laboratory will be encouraged to take a more active interest in the branch stations' activities. This, of course, will work both ways as we continue to encourage the divisions and branches to participate in program conferences of the Laboratory.

A 3-day demonstration of the Forest Products Laboratory log grading system is scheduled to be held in southern Illinois, probably on the Kaskaskia Experimental Forest, before June 30.

Feeding tests of wood molasses under way at the University of Illinois and the University of Missouri should be completed in 1952. We plan to help the branch stations and the universities prepare a cooperative report on these studies. No extensive new work is scheduled in this field at this time.

The Forest Products Research Society now has no section between Chicago and High Point, North Carolina. Since these sections can be very effective in furthering improved utilization, we will continue to take an active interest in the formation of such a section to include all of Kentucky and those portions of Indiana and Ohio roughly south of U. S. Highway 40. This will be known as the Ohio Valley Section.

Listed as "desirable" are several additional sawmill training demonstrations and log grading instructions. There have been specific requests for these, not only from public foresters but from industry. The proposed survey of farm woodland harvesting problems ties in with one of our major utilization problems--the lack of mechanization in our primary forest industries. The need for a small capacity and inexpensive dry kiln for sawmills and small secondary plants where steam is not available is recognized and is a problem which appears to have promise of early solution.

FOREST MANAGEMENT

Although funds available for the Division of Forest Management were reduced somewhat during the year and part of our staff was diverted for a time on the study of equipment and manpower needs of the forest products industries, a number of projects started in previous years bore fruit and we began several new studies. Current projects, some of them long-term, include such basic studies as the relationships of site characteristics to stand development and growth, effects of silvicultural treatments on stand development, and the effects of sources of seed and racial variations on plantation success. Particular emphasis has been placed on experiments to test and demonstrate the effects of various methods of cutting on stand structure, stand improvement, establishment of reproduction, and financial returns. Forest planting studies continued to yield more information on suitability of species to sites, methods of ground preparation and planting, feasibility of stand conversion and reinforcement plantings, and revegetation of strip-mined lands.

SILVICULTURE

Sprouting of hardwood trees.--Because most of the hardwood trees in the Ozarks are prolific sprouters, they create special problems for foresters who want to eliminate poor trees to make room for better ones. Toward the end of the year we began analyzing data collected during the past several years on factors affecting the sprouting of trees in the Missouri Ozarks. This information will be published in the belief that it will increase the efficiency of work now being done on the use of chemicals to control undesirable woody plants.

Natural regeneration.--Before any decision is made on planting an old field, a survey of natural stocking should be made; the field might develop a good forest stand without costly planting. This is one conclusion to come out of a study of natural forest succession on old fields in Ohio. The field work for this study was completed during the year. We found that most of the natural reproduction consists of species with low commercial value, and that mortality during the first 5 years of seedling development probably is high. In general, density of stocking decreased as the distance from the seed source increased. Fields larger than 45 acres showed little promise of natural restocking with commercially valuable species. The study shows that even areas with adequate stocking may need planting if low-value species predominate. The availability of good seed sources of the desirable species should be considered in deciding whether or not to plant.

A study of a strip-mined area in Ohio has shown that good natural stocking is possible on some of these lands located near seed sources. On one area we found an average of 4,800 trees per acre.

Site appraisals for pine.--This study was set up in 1951 to evaluate sites in the hilly, unglaciated parts of Ohio, Indiana, and Kentucky for their capacity to grow white, red, and shortleaf pines. The effects of topography, aspect, and soil characteristics on the growth of plantations of these species are the basis for appraisal. About half of the field work was completed this year.

Site index for white oak.--A paper entitled "Stand Density as a Factor in Estimating White Oak Site Index" was published in the August 1951 issue of the Journal of Forestry. It reported that the height growth of even-aged white oak is significantly modified by stand density. Site-index curves, corrected for variation in stand density, were presented for white oak in southeastern Ohio.

"Relation between Soil Characteristics, Topography, and the Site Index of White Oak" was published as a Station Technical Paper.

CUTTING METHODS

Management of upland hardwoods in southern Illinois.--These studies, begun in 1948 at the Kaskaskia Experimental Forest, are long-term projects. They include comparison of even-aged and all-aged management, lengths of rotations and cutting cycles, intensive and extensive silvicultural treatments, and various combinations of these variables. Before 1951, cuttings were completed on 12 compartments totaling 206 acres; in 1951 we completed cutting on another 17-acre compartment and began cutting on 7 more.

A tentative problem analysis and review of literature dealing with stocking and tree economic maturity for southern Illinois and adjacent areas was completed. It discusses and evaluates stocking problems in the light of published material from other regions as well as the Central States.

Logging costs.--Harvesting costs are being determined in the Kaskaskia compartments. We completed a supplementary study to obtain an estimate of the costs of small hand tools such as crosscut saws, axes, wire rope, and similar supplies used in cutting and skidding. The following items were expended per 100 M bd. ft. of logs cut, skidded, and yarded at the roadside:

Felling and Bucking

Item	Units expended per 100 M bd. ft.
Axes	1.3
Cross-cut saw blades	0.6
Bow saw blades	1.9
Files, saw and others	6.2
Cross-cut saw handles	1.3
Maul handles	1.9
Mauls	2.3
Steel wedges	1.3

Skidding and Bunching

Item	Units expended per 100 M bd. ft.
Wire rope, 1/2 and 3/8 in. (feet)	231.3
Cant hook handles	1.1
Logging chain, 3/8 in. (feet)	5.2
Choker ferrules	1.1
Choker hooks	1.1
Socket metal (pounds)	1.9

Using the 1951 retail prices shown in large mail order house catalogues, these supplies would cost, per 100 M bd. ft. of sawlogs, $26.70 for felling and bucking and $31.80 for skidding and bunching.

Farm woodland demonstrations.--The third annual harvest, mainly an improvement cut, was made during the year on the "good" farm woodland demonstration at the Kaskaskia Experimental Forest (table 1).

Table 1.--Products harvested from the "good" farm woodland during the first complete cut

Product	Unit of measure	Volume harvested by years			Total
		1949	1950	1951	
Cabinet veneer logs	Bd. ft.	310	260	0	570
Grade 1 sawlogs 1/	Bd. ft.	1795	405	800	3000
Grade 2 sawlogs	Bd. ft.	1260	655	1185	3100
Grade 3 sawlogs	Bd. ft.	1435	2775	1740	5950
Tight cooperage	Chord ft.	27	0	0	27
Pit props	Lin. ft.	480	240	0	720

1/ Forest Products Laboratory log grades were followed in grading all sawlogs.

This 24-acre tract of upland hardwoods has been divided into three blocks, one of which is cut each year. By dividing the woodland in this way, annual improvement cuts are more concentrated, cheaper, and apparently more effective. The entire tract has now been cut over once.

The first few cuts on this woodland will be more in the nature of rehabilitation or improvement treatments than true harvest cuts, and most materials removed will be of low quality. However, a net return is being obtained as result of the operation.

A total of 232 man-hours of labor, 14 power-saw-hours, and 12 tractor and sulky hours were used to fell, buck, skid, and yard the products. The woodland contained 16 cull trees per acre that were killed by girdling. It probably will not be necessary to repeat this treatment for at least 5 years. At current local prices the products harvested in the first three annual cuts had a total value of $306.00 at roadside. After deducting equipment and girdling costs, the gross return was about $1.00 per man-hour. As this previously unmanaged tract is converted to a managed forest, the returns should increase substantially.

A second woodland, 22.5 acres in size, has been set aside at the Kaskaskia. This stand of timber is badly deteriorated, for it was high-graded, grazed, and burned for several years before it was purchased by the Forest Service. The first rehabilitation or improvement cut was made last year. A total of 22 M bd. ft. of merchantable sawlogs (about 1 M per acre) was salvaged and 22 cull trees per acre were killed. The net return after deducting the cost of logging and improvement work was $6.50 per acre. The objective of this study is to determine and demonstrate the methods and economics of rebuilding a badly deteriorated farm woodland to its maximum sustained production.

Cutting practices in bottomland hardwoods.--We began a study in this type in 1951 in cooperation with the Shawnee National Forest to determine the best cutting practices for growth and yield and for securing desirable reproduction. A 45-acre tract was selected for the experiment and subdivided into twelve 2-acre plots with isolation strips. This stand ranges from about 30 to more than 60 years old and consists mainly of silver maple, cottonwood, ash, sweetgum, and elm. Its total basal area is 114.5 feet per acre for all trees larger than 4.6 inches d.b.h., and it contains a gross volume of 10,142 bd. ft. (International rule) per acre in trees larger than 10.6 inches d.b.h. Tax records indicate part of the area was in corn in 1918.

Each plot was inventoried and marked for cutting or girdling. The treatments to be tested are: (1) clear cut, (2) heavy

rehabilitation cut, (3) light cut, and (4) control (no cutting or girdling). All work on establishing this study will be completed in 1952.

Comparison of systems of management.--At the Brayton Memorial Forest, owned by Iowa State College, a farm forestry tract of approximately 50 acres has been selected to compare four methods of cutting. By the end of 1951 we completed a 100-percent inventory of the tract. This demonstrational study, a cooperative project with the Forestry Department, Iowa State College, and Region 9, will involve marking all trees for cutting and includes comparisons of the following systems of management: (1) individual tree selection cutting at 1-year, 5-year, and 10-year cutting cycles, and (2) the 2-cut shelterwood system.

Stocking and methods of thinning.--First of a series of comprehensive stocking and methods-of-thinning studies was installed in Missouri this year. The over-all objective of these studies is to provide bases for selecting, for different sites, the combinations of stand composition, stocking, size-class distribution, and length of cutting cycle that will best perpetuate the stand and give the greatest growth and highest-quality products consistent with the needs of the owners.

The study started this year is in a 31-year-old shortleaf pine pole stand established by natural regeneration after an oak-pine stand was harvested in 1918 to 1920. Before 1933 the area was burned over periodically by uncontrolled fires. Since then it has been a part of the Clark National Forest and has not been burned. In 1934, at age 14 years, most of the overstory hardwood trees were removed and the pine was thinned to about 600 stems per acre. Just before the current thinning, the stands had an average stocking of about 570 trees totaling 1,300 cubic feet per acre. Most of the trees were in the 6-inch, 7-inch, and 8-inch d.b.h. classes. The dominant and codominant trees averaged about 50 feet in height, indicating a site index of 70 for pine.

The primary objectives of this study are to find out and compare the growth rate, type and quality of products, and the composition, quality, and quantity of natural regeneration in shortleaf pine stands when:

1. All hardwoods are removed and the basal area of pine is reduced to 50, 70, 90, 110, and 110± square feet per acre, and a check is maintained at approximately 130 square feet per acre.

2. All hardwoods are removed and the basal area of pine is reduced to 70 square feet per acre by (1) thinning from above, (2) thinning from below, and (3) a combination of these with special attention to spacing.

3. The basal area of pine is reduced to 70 square feet per acre by a combination of thinning from above and thinning from below with special attention to spacing and (1) all the hardwoods are removed and (2) only the overstory hardwoods are removed.

4. The basal area of pine is not reduced and (1) all the hardwoods are removed and (2) no hardwoods are removed.

The secondary objective is to find out to what extent the succeeding growth rate and quality of individual trees are correlated with tree size, crown size, crown class, and growing space.

The thinning and other treatments on the thirty 1-acre areas (3 replications of 10 treatments) were made from April through July 1951. Trees were felled with a two-man power saw. Merchantable products were skidded in tree lengths to landings with a standard Willys Jeep equipped with an A-frame and winch. Although this is primarily a silvicultural and biological study, not an economic study, the products--some 42 M bd. ft. of sawlogs and 8,100 fence posts--returned most of the cost of thinning.

Plantation management.--A similar study in 14-year-old planted shortleaf pine was set up in cooperation with the Wayne-Hoosier National Forest on two areas in southern Indiana to find out the value of pruning and thinning young plantations. The stands, located on uplands formerly in old fields and averaging 1,132 cubic feet to a top diameter of $2\frac{1}{2}$ inches, were thinned from below and from above to four intensities: (1) heavy, (2) medium, (3) light, and (4) no thinning. The residual basal areas in the heavy, medium, and light thinnings were 80, 100, and 120 square feet. In one of the areas the trees on half of the thinned plots were pruned.

We completed detailed working plans and tentatively selected experimental areas for three pine plantation management studies to be established in cooperation with the Shawnee National Forest. These tests are set up to determine comparative costs, growth, and yield of shortleaf pine as affected by various methods and intensities of thinning. These studies include (1) systems of thinning (including row thinning), (2) some economic aspects of pruning, and (3) optimum stocking studies by sites. In addition, to get information for other sites, similar studies involving some 36 experimental plots will be established in cooperation with the Illinois Agricultural Experiment Station.

In Iowa we began a thinning study in a 53-year-old white pine plantatation. Part of the plantation, varying in density from 370 to 387 trees per acre, was divided into eight 1/5-acre plots for the study. Four thinning intensities were tried; two plots were left unthinned, and two each given a light, moderate, and

heavy thinning. The cutting resulted in marked differences in numbers of trees, basal area, and cubic volume of the residual stand (table 2). All material removed in the cutting operation was sawn into lumber for use by the land owner in farm building construction and maintenance. Because the material was not sold but was cut as needed for local use over a period of several months, no specific data on the sale value of the products were obtained. It is significant, however, that growth rate to age 53 years has ranged from about 400 to more than 500 bd. ft. per acre per year in this stand.

Table 2.--Average stocking, basal area, and volume per acre of a 53-year-old white pine plantation in Iowa before and after thinning to four intensities

Stand conditions	Intensity of thinning			
	None	Light	Moderate	Heavy
Stocking (No. trees)				
Before thinning	377	387	385	370
After thinning	377	290	250	220
Basal area (Sq. ft.)				
Before thinning	250.0	247.6	236.7	223.5
After thinning	250.0	200.1	172.8	148.8
Volume (Cu. ft.)				
Before thinning	5,116.5	4,986.7	4,696.5	4,163.7
After thinning	5,116.5	4,156.5	3,612.2	2,941.2
Volume (Bd. ft. for trees over 10 inches in diameter)				
Before thinning	27,840	26,515	24,775	21,305
After thinning	27,840	24,530	21,450	16,905

We continued to work on a manuscript which will give the results of a stand objective study and present interim stocking grades for the upland hardwoods of southern Illinois and similar adjacent areas by site types.

MENSURATION

Aspen growth and mortality.--Bigtooth aspen (Populus grandidentata, Michx.) generally occurs as small even-aged stands in openings created by logging, windthrow, or severe fires. On good

upland sites it will reach sawlog size in 40 to 50 years. In recent years a good market has developed for aspen for lumber and veneer and its sale value has increased.

In 1948 in northeastern Iowa we began an exploratory study to determine the silvicultural rotation age of bigtooth aspen. Seven plots located in 50-year-old and 80-year-old unmanaged stands were reinventoried in 1951 to determine stand condition and mortality. Losses were excessive. In the 50-year-old stands, for example, the number of living trees dropped from 172 to 128 during the 4-year period; this represents a loss of 26 percent in this short period. In the 80-year-old stand the number of living trees dropped from an average of 60 trees per acre to 17, a loss of 72 percent for the same period. These studies indicate that serious deterioration of unmanaged aspen stands occurs in this locality as early as age 50, and that the economic rotation will perhaps not greatly exceed this period. A Station Note fully reporting the results of this study is ready for publication.

Subsampling circular plots.--A method was devised for subsampling circular plots by correcting for the convergence of radii when the sampling point originates at plot center. The method, described in "Random Sampling within Circular Plots by Means of Polar Coordinates," was published in the December 1951 issue of the Journal of Forestry.

FOREST REGENERATION

Direct seeding on old fields.--Direct-seeded experimental plots of shortleaf and loblolly pine in southern Illinois were examined last June, the fourth season after they were established. We also examined direct-seeded pilot-plant areas established in 1950 and 1951 in cooperation with the Shawnee National Forest. The data were combined with those from 6 years of direct-seeding tests in Ohio and the rough draft of a manuscript was written on direct seeding of pine on old fields in the Central States.

Hand-seeding methods generally have been unsuccessful from a stocking viewpoint and are too costly to compete with the planting of nursery stock. At best, direct seeding is uncertain and costs must be low enough to allow reseeding or planting a failed area without excessive total cost. Although the machine method tested in these studies (furrow and mechanical seeder) is much cheaper and somewhat more successful than hand methods, it, too, is less dependable than planting. The experimental plots established in 1947 and 1948 were successful on broomsedge cover types but not on annual weeds and grasses (table 3).

Table 3.--Fourth year results of machine direct seeding by cover types, species, and time of sowing

Species and time of sowing	Cover type		
	Broomsedge and light brush	Broomsedge and annual weeds and grasses	Annual weeds and grasses
	Average number of seedlings per 8 feet of furrow		
Shortleaf pine March 1948	1.7	1.2	0.1
Shortleaf pine December 1947	1.1	0.7	0.3
Loblolly pine December 1947	1.3	1.0	0.3

On two pilot plantings having broomsedge cover and machine-seeded in the spring of 1950, loblolly pine succeeded well on one area but shortleaf pine failed on both areas. A similar 10-acre broomsedge area, machine-seeded in 1951 to loblolly and shortleaf pine, was also a virtual failure. Machine seeding can be recommended only as a supplement to planting and then only under favorable biologic and economic conditions.

There are certain drawbacks to all methods of direct seeding. Although germination and survival may be acceptable, distribution of trees is usually poor. Clumps of trees which have to be thinned are common; this adds to the cost of stand establishment by direct seeding. Additional work is needed to get an accurate comparison of the costs of direct seeding and planting under varying conditions.

Direct seeding on forested areas.--Large areas of understocked and low-value forest stands within the present range of pine in the Missouri Ozarks can be made to produce larger volumes of timber by increasing the proportion of pine in the stands. In the past the amount of pine has been increased by underplanting or interplanting nursery-grown seedlings. This method has been quite successful where the seedlings were sufficiently released from the hardwood overstory, but it is relatively expensive. One possible method of reducing costs is to establish stands of pine by direct seeding. Two methods of direct seeding--seed spotting and broadcast seeding--are being tried in Missouri.

We began the seed spotting studies in 1940 and remeasured the plots at the end of the 1951 growing season. Although the data

have not been analyzed, it was evident in the field examination that pine can be successfully established on forest soils by fall seeding accompanied by complete overhead release or by seeding in forest openings.

In cooperation with the Clark National Forest we examined several areas, 1 to over 100 acres in size, that were broadcast seeded with shortleaf pine during the period 1945 to 1950. The seedings were made by the Clark National Forest on a trial basis on the Winona Ranger District. Most of the seedings were made in old fields or openings created by harvest or stand improvement cuts, burns, or blow-downs. The seed was broadcast at the rate of 1/4 to 1 pound per acre.

The seedings in forest stands were all successful but the seedings in old fields were failures. On the basis of randomly selected milacre quadrats, stocking of pine on the seeded areas in forest stands averaged about 1,800 seedlings per acre. Approximately 54 percent of the milacre quadrats contained one or more seedlings. However, since the results of these seedings varied considerably among the different sites and since the climatic conditions during the seeding period were quite favorable for seeding establishment, direct seeding tests must be continued on a trial basis to obtain information on the effects of site and seasonal weather variations.

Planting stock grades for yellow-poplar.--In the spring of 1951 we established field plots to find minimum standards of planting stock for yellow-poplar. The results at the end of the first growing season indicate that, to be assured of good initial survival, at least 80 percent of the seedlings in nursery-run stock should have minimum stem diameters of 4/20ths of an inch measured at the ground line, or 3/20ths of an inch measured 1 inch above the ground line. No significant relationships between initial survival and length of tops or shoot-root ratios were obtained. We found that the tops of large planting stock of this species can be pruned to lengths of 5 inches without a significant loss in initial survival. By top-pruning large stock before packing, considerable savings in shipping and packing costs can be made; moreover, field planting will be easier and cheaper.

Coniferous plantations in Iowa.--The two studies begun in 1949 to test the suitability of a wide variety of coniferous species for planting in Iowa were re-examined. Because of continuing damage from freezing, as well as other losses from other effects of soils and climate, we cannot, as yet, evaluate fully the comparative development of all species. Shortleaf and Virginia pines, Port-Orford-cedar, and western redcedar suffered the greatest damage from freezing, followed by Sitka spruce and noble fir. Other species planted--but not seriously affected by freezing--were eastern

white, red, Japanese red, lodgepole, pitch, ponderosa, Scotch, and Table Mountain pines; Black Hills, Norway, and white spruces; Japanese and European larches; eastern redcedar; one-seed and Rocky Mountain junipers; Douglas fir, northern white cedar, balsam fir, and eastern hemlock. Except for one species, one-seed juniper, initial survival has been generally good, averaging more than 80 percent. Initial survival and growth of Rocky Mountain juniper on the planting sites in western Iowa has been particularly good.

Methods of ground preparation and planting.--A detailed study was made of the third year results of the "Methods of planting and ground treatment studies" established in Ohio. We found that the pines survived and grew as well in the nonprepared ground as in any of the preparations used, and that the machine planting method was as good as hand planting methods. Therefore, the cheapest combination--machine planting on nonprepared ground--was as successful as any of the more expensive combinations tried. For yellow-poplar there is some evidence that plowing double furrows parallel to the land contour with the slice thrown downhill improves the planting site more than any other ground preparation method. The leaves of the trees so planted contained 17 percent more nitrogen than the average for trees planted by the other methods. This higher nitrogen content correlated with higher growth rate. The organic matter buried under the furrow may account for this increased growth, but since this may be just a temporary condition, we must wait several years for proof.

Fall planting.--The results of fall planting tests of shortleaf pine were published in the April 1951 issue of the Journal of Forestry and as Station Technical Paper No. 118. These tests showed that fall planting can be successful if done in early fall, on sites with moderate to heavy broomsedge cover, and if no scalp is removed. The natural ecological succession on old fields of southern Illinois has resulted in more and more of them having a heavy broomsedge cover suitable for fall planting. In a cover of annual weeds and grasses, scalping increased frost heaving from 10 to 54 percent. On broomsedge cover, frost heaving was 4 percent for unscalped spots and 13 percent for scalped spots.

The slit method without scalp removed reduced frost heaving for fall planting and was faster than the hole method or the use of scalps. It was successful for both fall and spring planted pine in broomsedge, or in broomsedge mixed with annual weeds and grasses or with scattered brush and briars. For spring planting, the slit method without scalp also can be used with good results on areas with a thin cover of annual weeds and grasses.

Forest planting on strip-mined lands.--Much of the progress in strip-mine reclamation research is reflected in the number and titles of publications released during the year: "Strip-Mine Lands

of the Western Interior Coal Province," "Reclaiming Illinois' Strip Coal Lands by Forest Planting," "How Strip-Mined Lands Grow Trees Profitably," "Overburden Analyses and Strip-Mine Conditions in the Northwestern District of the Ohio Coal Mining Region," "Overburden Analyses and Strip-Mine Conditions in Southeastern Ohio," "Differences in Infiltration Rates on Graded and Ungraded Strip-Mined Lands," "Reclamation of Lands Strip Mined for Coal," and "Illinois Spoil Banks Have Gone to Work." In addition, the following manuscript was completed for publication in 1952: "Effects of Grading Strip-Mined Lands on the Early Survival and Growth of Planted Trees." Another manuscript, based on 6 years of intensive study, is nearing completion; it deals with forest planting possibilities on strip-mined lands in Indiana.

During the year we remeasured 5-year-old experimental plantings on stripped lands in Ohio. The data obtained will be used in preparing a progress report covering the 5-year period. Preliminary findings show no benefits of grading strip-mined lands on survival and growth of trees. In general, pines have developed better on the more acid banks while hardwoods show better development on the calcareous banks.

During the past year a simplified field method for estimating the sulphur content in strata above coal seams was developed. This element is the major source of high acidity on spoils. We are now making laboratory studies in cooperation with Southern Illinois University to correlate total sulphur content with the visual estimate provided by the field test. At present the test appears promising. If it is successful, it will be helpful in identifying the strata above coal seams that cause toxicity in spoil banks. Once these sulphur-bearing strata are known, it may be possible to alter methods of stripping so that they are buried in the banks; there they will have no serious influence upon planted trees or other vegetation.

The study of the growing of Christmas trees on spoils in Illinois was continued. Additional test plantings of jack pine and redcedar were made during the year. We began this study in 1948 with the cooperation of the Illinois Coal Strippers Association, the United Electric Coal Company, and the Illinois Central Railroad. To date, a total of 15 acres of stripped lands have been planted to red, Scotch, and jack pines and redcedar.

Black walnut is one of the most promising species for use in rehabilitating strip-mined lands in Missouri, Kansas, Oklahoma, and Arkansas. Past plantings have indicated that it will grow rapidly on strip-banks in this area. It is generally agreed that black walnut trees grown in mixed stands usually are higher in quality and have a better growth rate than those grown in pure stands.

Preliminary results of studies testing the value of black locust as a nurse crop have shown that it is not only easy to establish but it is highly beneficial to associated species. A study designed to test the effects of black locust and four other species on the growth and quality of interplanted black walnut was established in 1950. The study area is located on strip-banks in southeastern Kansas. We made first-year survival counts at the end of the growing season (table 4). Since the primary objective was to study the development of walnut in fully stocked stands, it was necessary to replant failed spots of walnut, locust, and redcedar in the spring of 1951.

Table 4.--Survival of trees planted in the spring of 1950[1/] on lands strip-mined for coal near Pittsburgh, Kansas

Year of estimate	Black walnut	Black locust	Green ash	Eastern redcedar	Sycamore	Bur oak
	Percent					
1950	44.8	69.0	97.0	40.0	81.0	86.5
1951	96.7	90.4	95.8	65.5	79.5	67.4

1/ Failed spots of black walnut, black locust, and redcedar were replanted in the spring of 1951.

The original planting (1950) of walnut was made with stratified seed and the replanting (1951) was made with 1-0 nursery stock. This was done in order to have trees the same age from seed and to compare the development of individual trees established from seed with those established by transplanted seedlings.

Survival and height measurements were made at the close of the 1951 growing season. The survival of the combined 1950 and 1951 plantings is considered sufficient for the development of fully stocked stands and no further replanting is planned.

FOREST GENETICS

Hybrid poplars.--In search of fast growing hybrids for use in reclaiming strip-mined lands, we made a test planting of 50 clonal varieties of hybrid poplar trees on two types of mine banks in east-central Ohio. This study was made in cooperation with the Northeastern Forest Experiment Station and the Ohio Reclamation Association. Preliminary examinations of these plantings show excellent survival rates after 1 year.

Hybrid pine.--Two series of field tests on southern pine hybrids have been established in southern Illinois from seed furnished by the California Forest and Range Experiment Station. Planting stock was grown in the Union County State Tree Nursery, Illinois Department of Conservation. Loblolly pine from a Tennessee seed source was included in both series of tests. The first series, field planted in 1949, consisted of loblolly-shortleaf hybrids. At the end of 3 years, survival was good and the average heights for six small plots of each hybrid and for pure loblolly were as follows:

Species	Feet
Hybrid 1	4.56
Hybrid 2	5.59
Tennessee loblolly	6.10

We field planted the second series of hybrid tests in the spring of 1950. Survival has been good and growth differences between hybrids are showing up. However, none of the loblolly-shortleaf hybrids grew as tall as the loblolly. Neither the hybrids nor the Tennessee loblolly, in either of the two series, were damaged by the unusually cold winter of 1950-51.

Source of seed studies.--During the year we examined the plots set up 3 years ago in southern Illinois to study loblolly and shortleaf pine from different geographic seed sources. Differences in damage by the unusually severe cold of 1950-51 were noted for loblolly pine but none for shortleaf pine. These results were written up and accepted for publication in the Journal of Forestry. Loblolly grown from sources in Maryland, Virginia, Tennessee, and Arkansas showed little or no damage. Trees from sources in southeastern North Carolina, South Carolina, and Mississippi, on the other hand, suffered significantly greater mortality and had a significantly lower growth rate caused, in part at least, by the killing of leaders and the consequent production of a bushier top. The survival of trees from these sources in three of the five experimental blocks located over a wide area in southern Illinois was less than 80 percent, but in the other two blocks was higher than 90 percent. The survival of seedlings produced from seed coming from the northern part of the natural range of loblolly pine was generally above 90 percent.

We collected shortleaf pine seed in the fall of 1951 from trees located in Dent County, Missouri, for a study of racial variations of shortleaf pine. This study is being undertaken by the Southern Forest Experiment Station in cooperation with several agencies interested in comparing the growth and development of southern pine from different geographic sources of seed. Dent County represents the northernmost souce of seed for shortleaf pine in this study.

During the year an eastern redcedar seed source study was established on the upland soils of southern Illinois. Cedar stock grown from eight geographic seed sources was planted in these tests.

Chinese chestnut.--In cooperation with the Division of Forest Pathology of the Bureau of Plant Industry, and the Clark and Mark Twain National Forests, plots were established in 1951 to find out if some of the better Ozark sites are suitable for growing four varieties of Chinese chestnut. The trees were planted, fenced, and given complete overhead release.

FIRE STUDIES

Fire is a number one problem in forest and range management in the Missouri Ozarks. Deep-seated customs in the use of fire, lack of appreciation for timber values, conflicting use of woodlands, and carelessness are the basic causes of the 6,000 or more fires which burn over thousands of acres each year in the State. Over 99 percent of these fires are man-caused. Ten to 20 percent are accidental and the rest are intentional fires and fires which get out of control. Most are preventable fires.

This year marked the beginning of a forest and forest range fire research project in Missouri with the cooperation and encouragement of Region 9 of the Forest Service and the Missouri Conservation Commission. The work is being conducted through the Northern Ozark Branch Station, but many of the findings should be applicable to similar areas in Ohio, Indiana, and Illinois. During the year efforts were largely devoted to surveying the problems of fire control in Missouri and preparing a draft of a problem analysis which will be ready for review early in 1952.

During the past 18 years the State of Missouri and the Forest Service have made important strides in fire control through sustained fire-prevention activities and vigorous fire-suppression action. Starting with no protection at all, they now have over 8 million acres under protection in state districts and the national forests. State-wide, however, there are an additional 5 million acres of forest land still in need of protection from fire, and there is still a tremendous fire-prevention job to be done. Even in the protected area the annual burn is about 92,000 acres or about 1.15 percent of the total protected area; this is more than 10 times the goal set by forest managers and fire-control officers. The annual burn on the unprotected area is unknown but it is estimated that in some years over 1 million acres have been burned.

Since the number and size of fire problems are out of proportion to the resources available for research, the problems for study are being carefully screened to insure that the limited means

are best used. To provide a better basis for this selection, the fire problems were rated in importance and priority for inclusion in the research program. These ratings are based on discussions with state and federal fire-control officers, experience on going fires, study of the fire-control organizations, travel over the territory, and review of records and publications.

Fire-danger measurement and rating are given top priority for study because of their basic relationship to fire control, the expressed needs and opinions of fire-control officers, and the important use that can be made of the results. Such danger ratings are needed (1) to find the strength and distribution of the fire-control organization needed to cope with a prevailing situation, (2) to serve as a basis for comparing severity of seasons or areas and evaluating the fire-control effort, (3) to determine the proper conditions for prescribed burning, and (4) to serve as a measure in correlating the effects of fire.

One of the chief causes of drastic fuel changes is timber cutting with its attendant slash. For this reason we began a study of the deterioration of pine slash on cutting plots at the Sinkin Experimental Forest. The danger from slash is greatest the first year or two after cutting and gradually diminishes thereafter. This series of observations is expected to yield information on the rate of deterioration of pine slash under various degrees of cutting.

Fire effects have also been given high priority for study. The effects of fire may be either direct or indirect, harmful or beneficial. Some effects are quite clear-cut while others may not be obvious for a long time and are difficult to observe and measure. In analyzing this problem, the effect of fire on vegetation, soils and water relationships, microclimate, wildlife, recreational values, plans of management, and the economy of communities must be considered. We must know the effects of fire to assess damages and to use fire as a forest and range management tool. The results of studies on fire effects should be useful in clarifying the importance of fire prevention and be valuable in stating accurately the objectives of fire control. As a start in the study of fire effects, observations were made in two pine stands, which burned last spring, to get data on the eventual mortality of trees which were damaged but not immediately killed and to find ways of estimating delayed mortality soon after a fire.

Studies of fire-control equipment effectiveness, fire-suppression methods and their application, training and safety, and the cost-benefit relationships of fire control are rated medium to high in over-all importance. Since these problems can best be studied on going fires or after data are available from other studies, they will be studied as such opportunities arise. Reliable information on the efficiency of fire-line plows and other

power equipment is of particular interest since these are new tools in fire suppression in Missouri and need to be evaluated.

Because of the limited facilities and personnel, problems relating to fire prevention, equipment development, establishment and use of fire-control improvements, and prescribed burning are not being studied here at present. Some of this work is being done elsewhere, and other problems are rated of greater importance by the fire-control men interviewed.

PLANS FOR 1952

Forest management research is chiefly concentrated at the various branch stations in the Central States region. Plans for 1952 therefore deal mainly with the work programs prepared for each branch reported below. However, some problems, regional in scope, are undertaken by coordinated efforts of several branch stations. Among the latter are the following projects: (1) Direct seeding possibilities of conifers on old fields; from studies maintained during the past 15 years, a manuscript on this subject will be prepared for publication. (2) Planting stock grades for yellow-poplar; a progress report, based on observations made after the second growing season, will be prepared for publication. (3) Grading strip-mined lands; a manuscript, prepared in 1951 and entitled "Effects of Grading Strip-Mined Lands on the Early Survival and Growth of Planted Trees," will be published.

A long-term project, perhaps regional in scope, is proposed; it would include a comprehensive study of the effects of seed source and nursery practice on the survival and development of yellow-poplar. Detailed working plans should be prepared and seed collected in 1952.

Studies on optimum stocking in natural stands are in progress at the Ames and Northern Ozark branches and started at the Carbondale branch. We plan to expand these studies, extend them to the Buckeye branch, and coordinate them in a region-wide project.

Ames

First priority will be given to completing the 100-percent inventory and the harvesting of the four compartments which have been selected for the comparisons of systems of management on the Brayton Memorial Forest. The work will be continued in cooperation with the Forestry Department of Iowa State College.

The jack pine plantation pruning study in southeastern Iowa will be remeasured and repruned to maintain the desired ratio of live crown lengths.

The species adaptability study plots in both western and northeastern Iowa will be replanted in the spring of 1952.

The oak-hickory optimum stocking study plots in southeastern Iowa will be re-examined. If conditions have changed significantly, remeasurements will be made and a progress report prepared.

Time studies will be started to find the costs of preparing wood chips from the common species groups found in the province. Tests will also be made of the suitability of chips for cattle bedding, poultry litter, mulch, and as a soil amendment to provide organic matter.

Plans will be developed for planting studies on the Forest Service Purchase Unit tract in southeast Iowa.

The problem analysis for the problem area will be completed during the year.

A manuscript, "Effects of Grass Competition upon the Establishment of Hardwood Plantations in Iowa," will be completed and published by Iowa State College as a cooperative project.

Buckeye

The job of first priority for the year will be the selection and development of an experimental forest. Work will consist first of surveys and mapping of soil and forest types. Problem analysis will be completed and specific plans will be made for silvicultural and management studies. Work to place these plans in operation will be carried as far as time permits.

Field work on the study to determine desirable site standards for red, white, and shortleaf pines will be completed. We will continue to analyze leaves to determine potassium and calcium content in white oak stands of varying site quality. Similar analyses will be made for plantations of various species and sites.

Experiments in the care of hardwood plantations on strip-mined lands will be initiated. These studies will include underplanting of black locust stands combined with various intensities of release, as well as release cuttings in young plantations composed of black locust and other hardwoods.

Carbondale

As for the past 3 years, the comprehensive management study at the Kaskaskia Experimental Forest will require a large part of our time during 1952. We expect to complete all work on the seven compartments partially completed in 1951 and bring all record

summaries up to date. In addition, work will be started on seven more compartments covering about 170 acres. On four of these, encompassing nearly 90 acres, all cull trees will be eliminated. One of the long-cycle, oak-hickory compartments cut late last year will be interplanted to shortleaf pine and redcedar in an effort to create a mixed conifer-hardwood stand.

At the present rate all compartments will have been cut and the first improvement treatments completed by 1954. In addition, we will have made the second cut and treatment on several short-cycle compartments that were cut in 1949 and 1950. During the next year we will continue to develop a management plan for the 400-acre management unit. This tract will be used to study the techniques of plan preparation and execution for sustained-yield management and to further test systems of management which show promise in plot and compartment studies. We expect to have the plan and all other preparatory work completed on this unit so that cutting can be started as soon as all cutting-method test compartments have had one cut.

All work on establishing the mixed bottomland hardwood cutting-practice study will be completed, the first cut will be made through a national forest timber sale, products cut will be scaled, and a reproduction count will be made.

The manuscript giving the results of the stand objectives study and presenting interim stocking guides for upland hardwoods by site-types will be readied for publication during the year.

The fourth annual cut will be made on the "good" farm woodland during 1952. Results of the first three annual harvest and rehabilitation cuts will be summarized and a publication prepared in cooperation with Southern Illinois University. Also, in cooperation with the University, we will prepare plans for the management of a small tract of stream-margin type hardwoods recently acquired at the Kaskaskia Experimental Forest. The tract will be used to determine and demonstrate the best methods and economics of managing a small forest of this type. If time permits, the first cut and improvement treatment will be made.

We will continue to develop work plans and select experimental areas for studies of optimum stocking of upland hardwoods and the response of poles and small saw timber to release.

A publication will be prepared covering the early results of the loblolly and shortleaf pine geographic seed source studies and of the hybrid pine tests. The redcedar seed source plots will be examined and a file report prepared.

The experimental plots concerned with converting poor oak-hickory stands to mixed conifer-hardwoods will be examined, the

data evaluated and reported. One of the comprehensive management study compartments, clear-cut and planted to shortleaf pine and redcedar in the spring of 1949, also will be examined and the need for releasing the planted trees decided.

The rough-draft manuscript on direct seeding of pines in the Central States region will be revised for publication and a paper covering the demonstrations of species adaptation to site will be prepared. A new study testing the possible advantages of "ultrawet" in direct seeding of pine will be established. "Ultrawet" is a new commercial product designed to greatly increase the permeability of soils.

We will concentrate our efforts on completing the manuscript dealing with the coal-stripped lands of Indiana and the establishment and growth of forest plantings made on them. New studies on strip-mine planting will be undertaken. They will deal with the effects of different ages of black locust plantations upon other interplanted hardwoods and the effects of spacing on the development of mixed plantings.

The optimum stocking study for shortleaf pine plantations being developed in cooperation with the Illinois Agricultural Experiment Station will be established and the initial cuts made. Plots for the studies of thinning and pruning pine plantations will be laid out.

Northern Ozark

The study plots to test the adaptability of some 13 tree species to 12 types of banks resulting from strip mining of coal in the Western Interior Coal Province will be remeasured.

The data obtained from small experimental plots and larger-scale pilot tests of direct seeding as a means of establishing shortleaf pine in understocked and low-value oak stands within the present range of pine in the Missouri Ozarks will be analyzed. We plan to publish a report of the results.

Scheduled observations, measurements, and replantings on the Chinese chestnut plantings will be made in the spring of 1952.

Data collected during the last several years on factors affecting the sprouting of hardwood trees will be prepared for publication.

The trees in the walnut pruning study on strip-mined lands in Kansas will be measured in the spring of 1952 before growth starts. This measurement will yield data on wound healing, diameter and height growth, and sprouting during the two growing seasons

since the study was initiated. The development of sprouts on cleared portions of some of the main stems may nullify most of the effects of pruning. At the time of remeasurement one-half of the trees containing sprouts will be repruned to the original height.

Scheduled measurements will be made on the pine stocking study in the fall of 1952. The sprouts from the cut and girdled hardwood trees on those plots on which the hardwoods are to be eliminated will be sprayed with herbicides sometime in June. Analysis of the data on the stands before and after treatment and on the sample trees will be started.

Fire Studies

Most of the fire research during 1952 will be concentrated on:

Completing the fire problem analysis and distributing it to Advisory Committee members and others interested for final review.

Planning and carrying out analysis of fire and fire-weather records to determine the correlation of the Central States Fire Danger Meter scale with fire occurrence, behavior, and resistance to control, and to determine the normal frequency of days having various maximum ratings as shown by the meter, by 10-day periods, months, and seasons. This meter has been in use for several years and, while it has been considered inadequate by some, it has not been systematically tested to find out how well its ratings represent actual conditions. This study will be of value in deciding whether the meter is suitable or if revisions are necessary to make it more representative. It will be a first step in the study of danger measurement and rating.

Studying as many going fires as possible to determine the conditions of burning, rates of spread, fuel descriptions, and resistance to control, and to observe the behavior of fires in various fuels. This project also provides a way to keep abreast of methods of suppression, to study application of new methods, and to keep in contact with men in the field and their current problems in fire control.

Continuing and expanding the observations now being made on the survival and mortality of pine following burns of various intensities. We shall develop this into a formal study if the tentative results indicate that such an investigation should be made.

Studying the rate of deterioration of slash and deadened standing trees.

Collecting and analyzing data comparing the efficiency of work by men and machines in fire-line construction.

Maintaining a record of weather conditions in cooperation with the Salem District Ranger, and assembling other basic weather data for use in studying the relationship of weather to fire behavior and occurrence.

RANGE RESEARCH

All range research by the Station is being carried out at the Northern Ozark Branch. During 1951 we revised the range problem analysis, maintained scheduled work in sprout control, collected and analyzed data on national forest range reseeding areas, collected additional data on vegetation in established deer and livestock exclosures, and began planning two sprout control studies to be established on the Sinkin Experimental Forest in cooperation with the Division of Forest Pathology, Bureau of Plant Industry.

PROBLEM ANALYSIS

The range problem analysis was revised during the year. A few of the major conclusions reached in this analysis are summarized below.

Precipitation in the Ozarks is adequate for growing trees, cultivated crops, or improved pasture. The high rural population makes it essential that as many of the arable sites as possible be devoted to intensive, high-paying uses. However, most Ozark soils are low in fertility and a high percentage of the land is either too rough or too rocky for practical cultivation. Although the soils can usually be made moderately productive by applying lime and fertilizer, the average Ozark farm is smaller than the average farm in the better agricultural areas of the State. Nonarable lands yield some income from range cattle and hogs and from the sale of forest products.

The primary objective of the range research program is to find out where, how, and to what extent the raising of range livestock can contribute effectively to the long-time good of both the land and the people. At present, range livestock are the main source of cash income for many residents. However, on over 90 percent of the Ozark area, range livestock production is a temporary or conditional land use. There is conflict between range and forestry, as well as between both range and forestry and more intensive land uses. The object of range research on such land is to find out how range livestock production can be integrated with other uses. Here range research will be serving a declining range livestock industry which must be fitted in with other land uses that are increasing in importance.

In the Ozarks perennial grasses are the natural cover only on sites where the soil cannot absorb and hold enough moisture to support trees and crop plants. These natural grass areas occupy about 350,000 acres, mostly in the southwestern Ozarks, and are the only natural or permanent range land of consequence in the area.

Ultimately, range research will be focused on these natural range lands. Here we must work out management systems and techniques that will insure sustained high production. Some of the problems that need attention here are (1) controlling the spread of redcedar, (2) improving the range forage by reseeding, (3) managing the range to eliminate uneven grazing, (4) preventing deficiency diseases by supplemental feeding, and (5) determining proper rates of stocking and seasons of use.

SPROUT CONTROL

Sprout and brush control are important problems for the Ozark cattle rancher. Heavy stands of brush, sprouts, and trees reduce forage yields to practically nothing. Conversely, most Ozark sites will grow heavy stands of grass if woody plants are kept off.

Effective, economical methods for killing unwanted brush and trees are needed not only by farmers and ranchers who must have open land to grow forage, but also by foresters who want to kill poor trees to improve the forest and by right-of-way maintenance crews who spend enormous sums each year to keep down obstructing sprouts and trees.

Chemical methods are also used to kill plants that may harbor or spread plant diseases. In the Central States, effective tree-killing methods are needed in the study and control of oak wilt. We are cooperating with the Division of Forest Pathology of the Bureau of Plant Industry in two studies to test further the effectiveness of chemical control methods on several size classes and species of oak.

Scheduled work on the sprout control studies reported last year has been maintained. Final observations on these studies are scheduled for September 1953. A few of the outstanding early effects of treatment are presented below.

The sassafras and persimmon sprouting study.--This is an exploratory study in which both amine and ester forms of 2,4-D and 2,4,5-T were applied to the lower 12 inches of the trunks of sapling-size sassafras and persimmon. All solutions included 2.0 percent of the herbicide on an acid-equivalent basis. We applied the herbicides both in kerosene and in an emulsion of 1 part kerosene and 4 parts water thickened to the consistency of a thin paste with wheat flour. The pastes were applied with a paint brush; the oil solutions with a sprayer. The rate of application was 1 quart per 10 trees.

Treatments were applied June 1 and 2, 1950, and the last complete observations were made in July 1951. It appears that (1) sassafras is very susceptible to both 2,4-D and 2,4,5-T, (2) it is almost as susceptible to 2,4-D as to 2,4,5-T, (3) the ester and amine forms of 2,4-D and 2,4,5-T are about equally effective, and (4) oil-water emulsions are less effective than kerosene solutions. Flour-thickened oil-water emulsions of 2,4-D and 2,4,5-T killed a high percentage of the sassafras tops and reduced sprouting to a very low figure but kerosene solutions of these same compounds killed 100 percent of the tops and prevented all sprouting.

Persimmon is much harder to kill with 2,4-D and 2,4,5-T than is sassafras. The flour-thickened emulsions were ineffective on persimmon. Also, persimmon seems somewhat resistant to all forms of 2,4-D and to the salts and amines of 2,4,5-T. On the other hand, the top kill with esters of 2,4,5-T in kerosene appears to be 100 percent and so far there are no basal stem sprouts or root sprouts. However, other workers report that persimmon sometimes sprouts from the roots after showing no above-ground signs of life for two growing seasons. Later examinations will show the extent to which such delayed sprouting occurs here.

Sprout foliage spraying study.--In this study we sprayed reproduction-size sprouts in mid-June 1950 with water solutions of the following herbicides: 10.7, 19.4, and 32.4 percent solutions of ammate and 0.2, 0.5, and 1.0 percent solutions (acid-equivalent basis) of 2,4-D butyl ester, 2,4,5-T isopropyl ester, 2,4,5-T propylene glycol butyl ether esters, 2,4,5-T amine, and a 50-50 mixture of the propylene glycol butyl ether esters of 2,4-D and 2,4,5-T. Each mixture was applied in the early morning, at midday, and in the late afternoon.

Observations in September 1951 indicate that (1) sprays applied in the early morning, at midday, and in the late afternoon were about equal in effect; (2) the principal species, in order of decreasing susceptibility to chemical treatment, are sumac, sassafras, hickory, black oak, white oak, post oak, and blackjack oak; (3) ammate at the 1-pound concentration is relatively ineffective; (4) the butyl ester of 2,4-D and the isopropyl ester of 2,4,5-T are inferior to the propylene glycol esters of 2,4,5-T and to the 2,4,5-T amine; (5) 2,4-D and 2,4,5-T appear equal or superior to ammate for killing hickory, sassafras, and sumac; (6) ammate solutions containing 2 and 4 pounds per gallon were over twice as effective as the medium and high concentrations of 2,4-D and 2,4,5-T for killing oak but the cost per gallon of solution was about three times as great, and (7) the most efficient over-all results from the standpoint of the percent kill per quantity of material used were obtained with the medium concentrations of ammate and the low concentrations of 2,4-D and 2,4,5-T.

Sapling sprouting study.--This study tests amine and ester forms of 2,4,5-T at concentrations of 1.0 and 2.0 percent (acid-equivalent) applied in oil and in a flour-thickened oil-water emulsion to the lower 12 inches of trunk in September and December 1950 and June 1951. Three low-cut stump applications of ammate (that is, ammate crystals, 32.4 percent water solution, and flour-thickened 32.4 percent water solution) to post oak were also applied on each treatment date. We applied all chemicals with paint brushes to single-stemmed trees in the 1-inch, 2-inch, and 3-inch d.b.h. classes. Post oak and blackjack oak were the principal species.

Observations in September 1951 showed that (1) all materials were relatively ineffective when applied to the uninjured bark with a brush, (2) the 2 percent concentration was superior to the 1 percent concentration in brush-on treatments made in September and December but not in June, and (3) post oak was more susceptible than blackjack oak.

Ammate treatments in September on post oak stumps averaged 80 percent apparent kill and those applied in December and June averaged 90 percent. In all cases there was no worth-while difference in the effectiveness of ammate when applied as crystals, water solution, or the flour-thickened water solution.

The treatments listed above were applied only to single-stemmed trees in the 1-inch, 2-inch, and 3-inch d.b.h. classes. All other trees on the area were divided into two similar groups which were treated in December 1950 with a 2.0 percent solution of 2,4,5-T propylene glycol butyl ether esters in stove oil. On one group of trees the herbicide was sprayed on the uncut bark from the ground line to a height of about 6 inches. In the other group the small trees were cut and those over 4 inches d.b.h. girdled close to the ground. The stumps of the cut trees, the girdle, and all exposed bark below the girdle were sprayed with herbicide immediately after cutting.

The average apparent kills for these spray treatments were 68 percent for the uncut-ungirdled group and 76 percent for the cut-girdled group. The advantage of girdling or chopping before spraying appears to increase with diameter. However, this apparent effect may actually be due to the fact that the natural ability of trees to sprout after girdling decreases as diameter increases. Kills were lowest on blackjack oak, intermediate on post oak and white oak, and highest on black oak.

Apparent kills obtained by spraying the oil solution of 2,4,5-T ester to the base of standing trees were much higher than those obtained by applying the same material with a paint brush. The 2,4,5-T esters at 2.0 percent acid-equivalent concentration in oil apparently killed 69 percent of the post oak and 54 percent of

the blackjack oak. Paint-brush applications killed only 28 percent of the post oak and 10 percent of the blackjack oak. Obviously the spray applications covered the bark surface more completely and did a better job of penetrating into cracks and fissures in the bark. Better coverage of the bark surface, together with slightly higher rates of application, probably account for the pronounced superiority of spraying.

RANGE RESEEDING

In the Ozarks, high yields of herbage do not always produce high yields of beef. The limiting factor in the production of nutritious forage is not so much low rainfall as it is low soil fertility. Beef production, in turn, is limited more by the low quality of the forage than low volume.

Vigorous attempts to increase the yield and quality of the Ozark range forage by reseeding have been made by the national forests. Usually the area has been plowed or disked, treated with lime and fertilizer, and seeded to a mixture of tame pasture grasses and legumes. A few fair stands of redtop and lespedeza have been established with little ground preparation and no lime or fertilizer, but success without lime and fertilizer is rare. Most of the successful range reseeding trials in Missouri have employed improved pasture species and methods. The results of these trials indicate that:

1. Moderately productive improved pasture can be developed on almost any Ozark site that is not too steep, rocky, or too thin-soiled to plow.

2. Tame pasture grasses not only are more palatable than native species, they also "green up" earlier in the spring and remain green until later in the fall.

3. Orchard grass and Korean lespedeza probably are the most reliable species combination. One seeding of this type has carried one yearling steer per 2 acres from May 1 to October 1 for 2 years and produced an average daily gain of 1.6 pounds per steer.

4. Cattle on a range allotment will concentrate on a small tract of reseeded pasture to such an extent that (1) native forage goes to waste, (2) the pasture is severely over-grazed, and (3) the pasture is kept so short that the cattle make poor gains. So far these undesirable results have been avoided only where the pasture has been fenced separately or where stocking on the entire allotment has been reduced to the

approximate carrying capacity of the reseeded area. Sometimes neither of these measures is practical.

5. Improved pastures require persistent care to maintain soil fertility, to prevent serious reduction of the grass stand, and to keep down woody plants, weeds, and weed-grasses such as broomsedge.

6. Reseeding to native forage species should result in fewer management problems on a range allotment than seeding to highly palatable pasture mixtures. However, on all but the thinnest soils, it is questionable whether the native forage species will produce beef more economically than will tame pasture plants. It is believed that the net income per acre that can be realized from improved pasture is higher than can be obtained from native forage.

PLANS FOR 1952

At the Northern Ozark Branch the following range research work is planned for 1952: (1) Maintain scheduled work on going studies of sprout control, range reseeding, and range vegetation; (2) complete work plans and make initial treatments on sprout control studies to be conducted in cooperation with the Division of Forest Pathology of the Bureau of Plant Industry; (3) publish the range problem analysis; (4) prepare a popular article on range reseeding in cooperation with the Mark Twain National Forest; and (5) cooperate with the Missouri Wildlife Research Unit and the Missouri Conservation Commission on a paper on the effects of deer browsing on Ozark vegetation.

We also plan to prepare a popular article on sprout control in cooperation with the Forestry Department of the University of Missouri and develop plans for and begin a detailed study of forage resources and range management problems on the glades of southwestern Missouri.

FOREST INFLUENCES

FLOOD CONTROL SURVEYS

Widespread floods, many of them record-breaking, occurred throughout the central part of the Nation during 1951. The worst flood of the year occurred in July when the surging crest of the Kansas River, soupy with sediment, converged with the rampaging, muddy Missouri at Kansas City. These waters overflowed into densely populated and industrial sections causing great loss of life and enormous property damage. The entire lower Missouri Basin was affected as the flood-ridden Osage and others spilled into the bank-full Missouri. Headwater areas, flooded by overflowing creeks, were damaged extensively. Crops were washed out or covered with silt. Agricultural lands were made useless. Homes were flooded and many were destroyed. It is estimated that property damage exceeded a billion dollars, and that one-quarter of a million people were made homeless.

Many other record-breaking floods occurred in the smaller watersheds throughout the region. Among the worst were those of the Minnesota and Zumbro in Minnesota; Ontonagon in Michigan; Iowa and Maquoketa in Iowa; Little River in Kentucky; Vermilion, Spoon, and Panther in Illinois, and Kickapoo in Wisconsin. The Kickapoo flood cost six lives, destroyed 52 bridges, and caused extensive crop damage. The Panther Creek flood caused one death, considerable property damage, and $2,000,000 of crop damage.

Many local flash floods did considerable damage to crops and other property.

At the same time other parts of the region were experiencing severe droughts. In some areas water for home and industrial use had to be rationed.

These extremes in water problems also affected the Station's flood survey activities. During July, when many of the floods occurred, the Flood Control Section was being liquidated because of reductions in appropriations. Dr. Auten retired, Schmitt transferred to the Upper Michigan National Forest, and Morey was planning to wind up work by April 1, 1952. The floods and the hardships and damages resulting from them again centered attention on the great need for flood control work. In response, Congress, through supplementary appropriations, made additional funds available for flood survey work. This increased the flood survey work load at the Station to the pre-July level, but we lacked the men needed to do the job. To help out in a difficult situation, Becker was detailed from Forest Survey, and Schmitt was "borrowed" from Region 9.

Despite problems of reduction in force and later training of new personnel, much effective work was accomplished during 1951. The Flood Control Section participated in a number of surveys for which the Soil Conservation Service has primary responsibility and took part in the Federal Inter-Agency River Basin Committee (FIARBC) activities in the Arkansas-White-Red and Missouri River drainage basins. The status of work in the various watersheds at year's end is described below.

Cuyahoga (Ohio).--The Cuyahoga River Watershed presents a special flood control problem. Lying between and including parts of the cities of Akron and Cleveland, its lands contribute a troublesome amount of sediment to Cleveland harbor, yet the flood problem is not serious because of reservoir control. The field work was completed and office analyses started. A remedial program for forest land was developed to reduce the soil erosion responsible for the sediment. Many bare and eroding areas which are not revegetating naturally need to be planted with trees, and technical services are needed for advising forest owners on how to log timber to prevent excessive erosion.

East Fork of White-Patoka (Indiana).--The survey report was revised to conform with Forest Service Washington office comments. It is now in the Secretary's office.

Green (Kentucky and Tennessee).--The survey report for the Green River Watershed, released late in 1951, has the distinction of being the first postwar flood control survey report to be printed as a Congressional Document. It is also the first Department of Agriculture flood control survey report to be published complete with appendices. Officially known as House Document 261 (82nd Congress, 1st Session) the report recommends that (1) the total forest area on this 5,934,720-acre watershed be increased by 166,000 acres, (2) adequate protection from fire and grazing be given 2,151,000 acres of forest lands, (3) technical services be provided 1,664,000 acres of private forest land, (4) public agencies acquire and rehabilitate 438,000 acres of critical forest land, and (5) forest cover be restored on 728,000 acres of eroding forest land by planting trees.

It is estimated that such steps would increase the annual income from the forest lands in the watershed from $1,350,000 to $8,825,000. The over-all benefit-cost ratio for the entire recommended program is estimated to be 1.7 to 1.

Kentucky (Kentucky).--The first draft of the survey report was written.

Licking (Kentucky).--Originally the Licking River Watershed was to be included with the Kentucky in one survey. But early in

the survey, the watersheds were separated and work on the Licking was temporarily halted. When the Licking survey was resumed in December, the area under survey was expanded to include the Ohio direct drainage lying between Carrollton and Maysville, Kentucky. Field work on the Licking was completed, and supplementary work began on the additional area during 1951.

Red River of the North (Minnesota, North Dakota, South Dakota).--The survey work outline was completed.

Salt (Kentucky).--The survey report (prepared by the Northeastern Station) was reviewed in manuscript and returned, with comments, to the Northeastern Station.

Scioto (Ohio).--The survey report was revised to conform with Forest Service Washington office comments. It is now at the Bureau of the Budget for final review before being sent to Congress.

Upper Mississippi (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Wisconsin, South Dakota).--The survey report for this area was revised to conform with Forest Service Washington office comments. It is being revised by the Soil Conservation Service.

Arkansas-White-Red River Basin.--The Station helped prepare the forest research program for the Arkansas-White-Red River Basin. This research plan is a part of the comprehensive program being developed for this area.

Missouri River Basin.--Late in the year, work started on developing comprehensive programs for selected watersheds in the Missouri River Basin. These integrated programs, which include flood control measures as well as general resource development, production, and research items, must be drafted within the framework of House Document 373, Missouri River Basin Agricultural Program (81st Congress, 2nd Session).

The Osage River Watershed, located in Kansas and Missouri, was one of the watersheds selected for special study. Station personnel helped the Southern Station, which had responsibility for the flood control work, bring the 1949 edition of the Osage River Flood Control Report up to date. We also prepared the forest research program for the comprehensive report which is to be submitted to Congress early in 1952.

Plans for 1952

The flood control surveys for the Cuyahoga and Licking River Watersheds will be completed, and we expect the reports for these

and the Kentucky River Watershed to be well on their way to Congress before the end of the year.

We also expect to complete the detailed surveys and survey reports on nine small watersheds located in the Missouri and Upper Mississippi River Basins. The flood control programs for the small watersheds tributary to the Missouri River will be incorporated in comprehensive programs to be developed in conformance with Missouri River Basin Agricultural Program, House Document 373 (81st Congress, 2nd Session). The watersheds to be surveyed are:

Missouri Basin Watersheds

David's Creek (Iowa)
Honey Creek (Iowa)
Indian Creek (Iowa)
East Branch of Black Water (Missouri)

Upper Mississippi Basin Watersheds

Money Creek (Illinois)
Tom Creek (Illinois)
East Willow Creek (Minnesota)
South Fork of Crow River (Minnesota)
Lost Creek (Missouri)

Comprehensive programming, including a flood control survey, is also scheduled to begin on the Nishnabotna River Watershed in northwestern Missouri and southwestern Iowa.

FOREST INFLUENCES RESEARCH

How can we manage forests to conserve water and protect soils against erosion? That is the primary question forest influences research is set up to answer. It studies the effects of forests on soil, climate, and water relations, particularly on the kind and amount of runoff. It should be coordinated with forest management research in studies of the interrelations of soil, climate, water, and tree growth.

The Station's program of forest influences research is carried on at the Buckeye Branch, Athens, Ohio, in cooperation with Ohio University.

Water movement and storage in soils.--A soil moisture study was conducted from early spring to early winter on a ridge, a middle slope, and a lower slope in a typical oak forest in southeastern Ohio. Surface soils and subsoils were sampled weekly. Soils on all topographic positions were about at field capacity at the

end of April. The moisture levels then went down until near the end of August, when levels near the wilting point were reached. From the end of August to the end of October the moisture levels for the ridge and middle slope remained very low, while that for the lower slope went up a little. After October moisture levels rose steadily until December 31 when field capacity was again attained. This preliminary study served to test methods that will be used for comprehensive studies in the near future. Combined with results of previous studies, it will provide valuable information on the moisture regimes on forest lands in Ohio.

Biological relations.--A report on "The Concentration of Roots in the White Oak Forests of Southeastern Ohio" was published in 1951. The relation of root concentrations to soil horizons, texture, moisture equivalent, permanent wilting percentage, available moisture, tree age, site quality, tree bole volume, tree crown width, exposure of site, slope position, tree density, and herb density were reported in this publication. Site quality and tree age after 30 years were found to have no effect on root concentration in the stands studied.

Gaiser read a paper at the Soil Science Society of America meeting at State College, Pennsylvania, concerning root channels and roots in forest soils of southeastern Ohio. He pointed out that estimates of the physical and hydrologic characteristics of forest soils will probably be seriously in error unless some allowance is made for channels in the soil profile resulting from the decay of tree roots.

Plans for 1952

We are planning a publication on soil moisture in general and on some soil moisture relations in the forests of the unglaciated region of Ohio. It will deal with intake, storage, and use of water from forest soils. Basic soil characteristics affecting the distribution of moisture will be considered as well as the alteration of these characteristics by forest cover.

Soil moisture studies will be continued. Changes in the storage capacity of the soil will be investigated and detailed studies on the rate of transpiration of forest trees on different sites are proposed.

Studies on the number and distribution of channels made by decayed roots will be continued. The results to date, perhaps the most significant contribution to research in forest influences at the Buckeye Branch, will be published in the 1952 Proceedings of the Soil Science of America.

PERSONNEL

CENTRAL STATES FOREST EXPERIMENT STATION

(As of December 31, 1951)

ADMINISTRATION

PHILIP A. BRIEGLEB, Director; Mary L. Posey, Secretary; Kenneth G. Johnson, Editor; Virginia D. Simone, Stenographer

HERBERT C. BRADSHAW, Administrative Officer; W. R. Hudgens, Chief Clerk; *Karl W. Chrisemer, Robert W. Smith, John K. Vaughn, Ruth L. Hughes, Mary G. McDonald, Rachel E. Ford, Arnold Ross, Charles T. Singer, Violet J. Powell, Elaine Wood

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ROBERT K. WINTERS, Chief; Edith D. Clark, Secretary

Forest Survey

Photo Interpretation -- Karl E. Moessner, **Forrest D. Brunson

Field Inventory -- Maxwell E. Becker, Walter B. Metcalf, Philip Thornton

Growth and Statistical Procedures -- Chester E. Jensen

Commodity Drain -- James T. Morgan

Computing -- Lake F. Compton, Margaret K. Peirsol

Forest Resource Analysis -- James T. Morgan, O. Keith Hutchison

Farm Woodland Marketing Studies -- Robert K. Winters, Kenneth L. Quigley

FOREST PRODUCTS

_____, Chief; Virginia D. Simone, Stenographer

Primary Forest Industries -- Ralph K. Day

Secondary Forest Industries -- Marsden R. Brundage

FOREST MANAGEMENT

ARTHUR G. CHAPMAN, Chief; Evelyn Vukovich, Secretary

Silviculture -- G. A. Limstrom

FLOOD CONTROL

HAROLD F. MOREY, Subject-Matter Specialist, ***Maxwell E. Becker

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Brayton Memorial Forest, Manchester, Iowa

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BUCKEYE, c/o Ohio University, Athens, Ohio

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CARBONDALE, Post Office Building, Carbondale, Illinois

Richard D. Lane, Leader; Leon S. Minckler, Glenn H. Deitschman, Cleo Caraway

Kaskaskia Experimental Forest, Elizabethtown, Illinois

Donald L. Fassnacht, *B. A. Roach, **Thaddeus Harrington, Frank W. Kelso

NORTHERN OZARK, c/o University of Missouri, Columbia, Missouri

Franklin G. Liming, Leader; S. Clark Martin, Floyd B. Clark, Martha L. Wiggins

Sinkin Experimental Forest, c/o U. S. Forest Service, Salem, Missouri

Nelson F. Rogers, Wayne M. Harrison, John S. Crosby

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* Military furlough.
** LWOP to further education.
*** On detail.

PUBLICATIONS FOR 1951

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